

MARKSCHEME

MAY 2006

BIOLOGY

Higher Level

Paper 3

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Option D — Evolution

- D1.** (a) (i) strain 2, has the highest growth rate per day [1]
- (ii) strains 1 and 4 / strains 1 and 5 / strains 2 and 4 / strains 2 and 5 [1]
- (b) strains 4 and 5 have a higher optimal temperature than the other strain / strains 4 / 5 have a higher optimal temperature than 1 / 2 / 3;
 strains 3 and 4 have similar optimum temperatures;
 strain 5 has the highest optimum temperature of all strains / not below 50°C;
 strains 1, 2 and 3 have greatest tolerance range;
 strain 5 has smallest range in tolerance / strain 5 range smaller than 1/2/3/4; [2 max]
- (c) less competition;
 less predation (by bacteriophages);
 adaptation to climate change; [1 max]
- (d) with increasing spread of thermal/temperature tolerance/preference there is less competition for space / food;
 increased spread of thermal/temperature tolerance/preference leads to specialization / selection / isolation / niche building / speciation;
 with increasing thermal/temperature tolerance there is decreasing temperature range;
 when optimum temperature shifts to above 60°C the growth rate decreases;
 impact on survival rate / selected against;
 overspecialization may lead to extinction; [2 max]
- D2.** (a) sediments accumulate in layers in parts of sea/land;
 remains of living organism can be trapped;
 petrification / mineralization of tissues may occur;
 hard parts preserved best;
 preservation in (acid) peat;
 preservation in tar;
 preservation in resins/amber;
 preservation through freezing/dessication;
 preservation as prints and moulds / casts; [2 max]
- (b) *Two answers required for [1]*
 reducing atmosphere / no free oxygen;
 a lot of hydrogen and ammonia;
 water vapour present;
 (carbon present as) methane;
 solar / high energy radiation;
 lightning;
 high temperatures;
 intense volcanic activity;
 radioactive elements present; [1 max]

- D3. (a)** eukaryotic cells contain mitochondria / chloroplasts;
 mitochondria and chloroplasts (have evolved from) independent free living organisms / bacteria / prokaryotes;
 these organisms were taken into (heterotrophic) cell;
 by endocytosis;
 primitive prokaryotic cell entered another as a parasite;
 mitochondria and chloroplasts carry out aerobic respiration and photosynthesis;
 for mutual/symbiotic benefit;
 mitochondria and chloroplasts have similar characteristics to prokaryotes;

[4 max]

- (b)** *explanation:* **[4 max]**
 proteins / amino acids or nucleic acids can be used to deduce / construct phylogenies/ancestry of organisms;
 differences in the amino acid sequence of a compared protein can be related to the place in the phylogeny;
 DNA code is universal / protein structures are universal;
 differences in the genetic code/DNA of a compared genetic code / length of DNA can be related to the place in the phylogeny;
 differences accumulate over time at a constant rate;
 rate can be used to determine the time since divergence;
 the more similar the code/amino acid sequences the more closely related;

deficiencies: **[2 max]**

- rate not constant over time;
 protein rate obscures the rate in DNA (*e.g.* double point mutations at specific positions);
 selection/evolutionary pressure not the same for all organisms / genes;
 selection/evolutionary pressure not the same for a particular protein in a particular organism;
 does not take into account the more evolved and sophisticated repair mechanisms in higher evolved organisms;
 mutations may change the genetic code;
 back mutations possible;

[6 max]

Option E — Neurobiology and Behaviour

- E1.** (a) innate behaviour patterns develop independently of the environment;
 stereotyped responses to environmental stimuli;
 are controlled by genes / inherited from parents;
 some types of behaviour are better suited / adapted to their environment;
 behaviours (alleles for these) selected for;
 increases the survival of those organisms;
 leads to higher reproduction rate;

[4 max]

- (b) *effect of psycho-active drugs: [4 max]*
 some psycho-active drugs act like neurotransmitters;
 some psycho-active drugs act like neurotransmitters but are not broken down (at the receptors);
 some psycho-active drugs interfere with the breaking down of the neurotransmitters;
 affect the transmission of optic signal in the thalamus / optical cortex;

examples [2 max]:

amphetamines;
 nicotine;
 cocaine;
 cannabis;
 benzodiazepines;
 alcohol;

[6 max]

- E2.** (a) crab A **[1]**
- (b) $20(\pm 2)\text{ cm s}^{-1}$ / $13(\pm 0.5)\text{ cm s}^{-1}$ / $4(\pm 2)\text{ cm s}^{-1}$ (*units required*) **[1]**
- (c) the fastest water velocity resulted in the most direct approach;
the lowest water velocity resulted in the lowest hunting speed of the crabs;
the fastest water velocity resulted in the least lateral movement;
slowest crab has the most lateral movement;
intermediate water velocity resulted in the fastest movement between any two points; **[2 max]**
- (d) nature of the river bed may influence movement;
water temperature may influence the spread of the dye/movement of crab;
depth of the creek may influence the spread of the dye;
time of the day may influence the activity of the crabs;
presence of other (unseen) predators / presence of camera will influence the behaviour of the crabs;
age of crab will influence speed;
size / sex of crab will influence speed;
food availability;
width of plume;
concentration gradient;
dye might effect the behavior of the crab; **[2 max]**
- E3.** (a) *I*: aqueous humour;
II: fovea / yellow spot / macula lutea; **[2]**
- (b) a response to a non directional stimulus/non directional response to a stimulus **[1]**
- (c) slowing of heart rate;
lowers blood pressure;
constriction of the pupil;
saliva production;
constriction of ciliary muscle;
constriction of bronchioles;
increases gut movement;
increases secretion of gastric juices / pancreatic juices / tears;
relaxes gut sphincters;
erection of penis;
constriction of bladder wall;
relaxation of bladder sphincter;
gall bladder constriction; **[1 max]**

Option F — Applied Plant and Animal Science

- F1.** (a) 75% reduction / to 25% / 6 % decrease **[1]**
- (b) O₂ increases chances of survival / decreases mortality;
effect decreases as surviving piglets get older; **[2]**
- (c) piglets between 1.2 and 1.6 kg had the lowest overall mortality rate;
piglets with a birth weight below 1.2 kg had the highest mortality rate; **[1 max]**
- (d) over 21 day period the increase in mortality is greater for the oxygen group than
for the control group;
the effect of extra oxygen is greatest for the first 24 hours;
extra oxygen has a positive effect on the smallest and largest birth weights;
extra oxygen had a slightly negative effect on piglets between 1.2 and 1.6 kg /
optimum birth weight;
the positive effect of extra oxygen at birth cannot be concluded on the basis of
these findings;
birth weight is a better predictor for survival than extra oxygen; **[2 max]**
- F2.** (a) artificial insemination;
vaccination;
nutrient supplement;
hormone treatment;
IVF treatment; **[1 max]**
- (b) (i) plant productivity is a measure of the rate at which a plant is increasing in
dry (wet) mass/biomass;
(rate of) increase per gram of plant; **[1 max]**
- (ii) identify gene for ripening in tomatoes;
use sense / anti-sense technology to block (over-ripening) gene / mRNA is
rendered useless / mRNA cannot be expressed;
lower protein concentration / ripening of the tomato is delayed / stay firm;
Flavr-Savr tomatoes; **[2 max]**

F3. (a)

<i>Insect Pollination</i>	<i>Wind pollination</i>
large petals / with colors	small petals / no petals / dull coloration;
sturdy filaments (to hold anthers in a precise position)	long thin filaments (to hold the anthers loosely);
relatively small numbers of large / sticky / spiky pollens (carried by insects)	large amounts of small / smooth / light pollen (carried by the wind);
sturdy style holds the stigma in a precise position / short stigma	large/long feathery stigmas (protrude from the rest of the flower);
petals often scent and / nectaries / secrete nectar	no scent/nectar;
nectaries / secrete nectar	no nectar;

Award [1] for each correct row.

[4 max]

- (b) flowering depends on day length;
 there are short day and long day plants;
 length of night is significant (not day length) / unbroken period of “night”;
 there is a critical night length / minimum length of night controls the flowering process;
 growers decide when they wish to produce flowers by using greenhouses in which they can control light conditions;
 phytochrome exists in two interconvertible forms;
 interconversion of phytochrome pigment can measure daylength;
 red variety of phytochrome is inactive form;
 far red is active form;
 under daylight condition red is converted into far red variation;
 far red slowly converts back to red in the dark (at night);
 some plants are day neutral;

[6 max]

Option G — Ecology and Conservation

- G1.** (a) 8 m (*units required*) **[1]**
- (b) as oxygen increases, egg development increases (up to 8m);
as temperature increases egg development increases (up to 8m);
when the temperature is 27.6 °C (± 0.2) and oxygen is 3.5 ppm (± 0.2) egg development is maximum;
after 8 m there is a decrease in egg development despite little change in the oxygen concentration / temperature; **[2 max]**
- (c) (i) optimal conditions for egg development found at 8 m;
distance (> 8 m) starts having a negative effect on egg development despite (near) optimum levels of oxygen and temperature;
distance from the high tide line is more important than both oxygen / temperature for egg development; **[2 max]**
- (ii) wave action;
predators;
human interaction;
tides;
humidity/dessication;
salinity;
pollution;
nature of sand; **[1 max]**
- G2.** (a) members of two species that live together in a close relationship from which both benefit **[1]**
- (b) *I:* nitrates: / NO_3^- ;
II: nitrites / NO_2^- ;
III. ammonia / NH_3 / ammonium / NH_4^+ (ions); **[3]**

- G3.** (a) nature reserves often need active intervention / management;
 degradation through human influence must be curtailed / restored/ control of human exploitation;
 limited access to sensitive zones;
 promotion of the recovery of threatened species;
 curtailing/stopping human intervention such as poaching;
 control/elimination of non-indigenous (alien) species;
 educating (local) community to improve understanding of existence of nature reserve / impingement on their farming;
 reintroduction of (locally) extinct species;
 buffer zones may be necessary;
 continued regular monitoring of (endemic) species;
 permits *in situ* conservation;
 legislate to protect area/ enforce protection of area using nature reserve wardens;
 culling of animals/ contraception should the population exceed resources/carrying capacity;

[6 max]

- (b) amount of organic matter in the soil increases due to excretion / decay;
 soils structure improves as organic content rises / increasing water retention / aeration / minerals content;
 soil structure improves as organic content rises so does drainage of excess water;
 soil erosion is reduced by binding action of roots of larger plants/erosion is increased due to roots/ burrowing/grazing animals;
 amount of mineral / nutrient recycling increases;
 resulting changes in the atmosphere;
 increasing biomass increases recycling / decomposers, fungi and bacteria recycle;
 decaying plants increase soil pH;
 increase oxygenation of water due to photosynthesis/ decrease water oxygen due to decay;
 light intensity decreased due to leaf canopy;

[4 max]

Option H — Further Human Physiology

- H1.** (a) 25 deaths per 10 000 persons year⁻¹ (*units required*) **[1]**
- (b) increase in systolic pressure gives rise to increased death rate;
 increase in systolic pressure always increases the death rate / increasing diastolic pressure does not;
 from <120 to 159 mm Hg systolic BP as the diastolic pressure increases there is relatively little change in death rate;
 above 160 mm Hg systolic as associated increase in diastolic pressure does not lead to an increased death rate / irregular effect;
 highest death rate when systolic pressure/160/ > 160 / accompanies low diastolic pressure; **[2 max]**
- (c) (i) 90/91/92 mm Hg (*units required*) **[1]**
- (ii) the greater the difference between diastolic and systolic pressure the higher the death rate;
 high diastolic blood pressure (>99/>100 mmHg) combined with high systolic blood pressure (>160/>159 mm Hg) is not as detrimental as low diastolic blood pressure (<70 mm Hg) and high systolic blood pressure (>160/>159 mm Hg);
 diastolic blood pressure below 100 mm Hg and systolic blood pressure below 120 mm Hg little effect on the death rate;
 systolic value always a better indicator of risk than diastolic value; **[3 max]**
- H2.** (a) peptide / protein, *e.g.* insulin, growth hormone, ADH, TRH;
any other example.

 steroid *e.g.* progesterone, oestrogen, testosterone, corticosteroids;
any other example.

 tyrosine derivatives, *e.g.* thyroxin;
any other example;
Both type and example of hormone required for [1] **[1 max]**
- (b) *endo:* hydrolyze/break down (peptide) bonds in polypeptide (chain at specific amino acid combinations);
exo: hydrolyze/break down (peptide) bonds at the ends of polypeptide chains;
 different exopeptidases needed to remove amino and carboxyl terminals; **[2]**

- H3. (a)** erythrocytes / rupture / have a life span of about 120 days / 4 months;
 destroyed/phagocytosed by Kupffer cells;
 reticular endothelial system;
 hemoglobin is split into heme groups and globins/proteins;
 globins/proteins are hydrolyzed to amino acids;
 iron is removed from heme/iron stored;
 heme converted to biliverdin/bilirubin/bile pigments;
 bilirubin/bile pigment transferred to bile;
 amino acid deaminated;
 ammonia is converted to urea / carbohydrate respired; **[5 max]**
- (b)** adult hemoglobin and fetal hemoglobin have S-shaped dissociation curves;
 both fetal and adult hemoglobin have a high affinity for oxygen at high partial pressure of oxygen;
 fetal hemoglobin always has a higher affinity for oxygen at corresponding partial pressures of oxygen;
 fetal dissociation curve lies to the left of the adult/maternal dissociation curve;
 in the placenta where maternal and fetal blood come into close proximity there is a low partial pressure;
 fetal hemoglobin must have a greater affinity for oxygen otherwise the maternal oxy-hemoglobin would not dissociate;
 relationship between fetal and adult hemoglobin dissociation curves does NOT change;
 the difference in adult and fetal hemoglobin structures lead to differences in affinity; **[5 max]**
Response must contain statements for both adult and fetal hemoglobin, if not award [3 max]. Credit can be given for a clearly drawn and correctly labeled diagram.
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